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GSO 210 (1994) (English): INDUSTRIAL SAFETY AND
HEALTH REGULATIONS – HAZARDOUS MATERIALS – EXPLOSIVE
DUSTS, EXPLOSIVES AND BLASTING AGENTS



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الجزء الرابع - المواد الخطرة

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**INDUSTRIAL SAFETY AND HEALTH REGULATIONS –
part 4: HAZARDOUS MATERIALS – EXPLOSIVE DUSTS,
EXPLOSIVES AND BLASTING AGENTS**

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**INDUSTRIAL SAFETY AND HEALTH REGULATIONS —
part 4: HAZARDOUS MATERIALS – EXPLOSIVE DUSTS,
EXPLOSIVES AND BLASTING AGENTS**

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INDUSTRIAL SAFETY AND HEALTH REGULATIONS —
part 4: HAZARDOUS MATERIALS SECTIONS –
EXPLOSIVE DUSTS, EXPLOSIVES
AND BLASTING AGENTS

1. SCOPE

This standard is concerned with industrial safety and health regulations, explosive dusts explosives and blasting agents.

2. EXPLOSIVE DUSTS

2.1 Definitions

Dust: An air suspension of solid particles of any material.

Dust Explosion: A rapid combustion of a cloud of combustible particulate matter in a confined space where heat is generated at much higher rate than it is dissipated,

2.2 Scope

This section applies to industrial plants or locations where combustible dust is produced and handled; for example, factories, handling and packaging of sugar or flour, pulverized fuel systems, grain storage elevators, etc. This paragraph gives general safety rules to be followed at such locations, however, it does not include detailed requirements for each type of plant or operations. Design, operation and maintenance of each individual plant shall be based on the general requirements of this paragraph and good engineering practice as related to a specific dust.

2.3 Buildings and Structural Requirements

2.3.1 Buildings shall be constructed of non-combustible materials.

2.3.2 Dust producing areas shall be isolated by 2 hour fire rated partitions.

2.3.3 There shall be at least one outside wall or roof designed to provide explosion relief protection.

2.3.4 Horizontal surfaces within the building shall be kept to a minimum. Unavoidable horizontal surfaces which are not accessible for frequent cleaning shall be sloped to a minimum of 60 degree with the horizontal.

2.3.5 Stairs and elevators shall be protected from dust areas by fire doors and fire walls.

2.3.6 Floors and walls shall have a smooth finish without cracks and crevices.

2.3.7 Openings in the dust enclosures shall be avoided. Openings for pipes, conduits, ducts or equipment shall be sealed.

- 2.4 Equipment
 - 2.4.1 General
 - 2.4.1.1 Whenever possible, all equipment producing, processing, creating, or handling dust shall be gasketed dust tight and shall be made of non-combustible material.
 - 2.4.1.2 Interior volume of equipment shall be kept to a minimum and designed and constructed to withstand maximum explosion pressure generated.
 - 2.4.1.3 Inside surfaces shall be smooth and accessible for cleaning.
 - 2.4.1.4 Whenever possible, explosion vents to the outdoors shall be provided
 - 2.4.1.5 Large equipment shall have gasketed access doors for cleaning.
 - 2.4.1.6 Belt drives in a dusty atmosphere are to be avoided whenever practical.
 - 2.4.1.7 Whenever belt drives are necessary, they shall be grounded to prevent danger of dust ignition by static electricity.
 - 2.4.1.8 Whenever belt drives are necessary, and where there is a possibility of belt slippage, torque limiting devices shall be used.
 - 2.4.1.9 Dust-sealed, antifriction bearings shall be used where dust may accumulate.
 - 2.4.2 Bins and Hoppers
 - 2.4.2.1 Material shall be non-combustible such as metal plate, concrete, etc.
 - 2.4.2.2 There shall be no direct openings between bins or hoppers.
 - 2.4.2.3 Hoppers shall be covered with dust tight covers or decks with explosion venting duct extending to outdoors.
 - 2.4.2.4 Pipe connections shall be air tight.
 - 2.4.2.5 Class 2 light fixtures shall be located inside.
 - 2.4.3 Conveyors
 - 2.4.3.1 Pneumatic
 - 2.4.3.1.1 Pneumatic conveyors containing explosive dusts shall be constructed of metal grounded to prevent ignition by static electricity.
 - 2.4.3.1.2 Headers and manifolds shall be of a size to maintain conveying velocities. The ratio of air to combustible material shall be substantially different from the ratio that presents an explosion hazard.
 - 2.4.3.1.3 The strength of the conveyors shall be adequate to contain the maximum explosion pressure developed by the specific dust contained.
 - 2.4.3.2 Belt

- 2.4.3.2.1 Belt conveyors handling dusty materials such as pulverized coal, grain, etc. shall be fully enclosed.
- 2.4.3.2.2 The conveyor enclosure shall be ventilated to maintain the enclosed atmosphere at less than an explosive dust-air mixture.
- 2.4.3.2.3 The discharge of the conveyor enclosure ventilating air shall be discharged through a dust collector.
- 2.4.3.2.4 The design of the conveyor and enclosure shall permit thorough cleaning of all dust accumulations.
- 2.4.3.2.5 The feed and discharge of belt conveyors shall be so designed that an explosive dust cloud will not occur.
- 2.4.3.3 Screw conveyors shall be fully enclosed in tight non-combustible housing with sealed covers.
- 2.4.3.4 Conveyor piping shall be sufficient strength to withstand maximum explosion pressure.
- 2.4.3.5 Conveyors shall be ventilated for dust removal to dust collectors.
- 2.4.4 Dryers
 - 2.4.4.1 Interiors shall be smooth and accessible for cleaning.
 - 2.4.4.2 Direct or flame heated dryers shall be located in an inert atmosphere.
 - 2.4.4.3 Steam for heating shall be low pressure (not to exceed 0.35 kg/sq cm).
- 2.4.5 Bucket Elevators
 - 2.4.5.1 Elevators shall be installed close to outside wall of the building.
 - 2.4.5.2 Elevator boot section and spouts shall be constructed so as to minimize the possibility of choking.
 - 2.4.5.3 Elevator construction shall be dust tight and of noncombustible materials.
 - 2.4.5.4 Inspection doors at head and boot section shall be provided.
 - 2.4.5.5 Bucket elevators shall be ventilated for dust removal to dust collectors.
- 2.4.6 Grinders
 - 2.4.6.1 Consideration shall be given to the use of inert gas in grinding equipment.
 - 2.4.6.2 Extra hazardous materials shall be handled in small batches or in such a way as to expose minimum quantities at one time.
 - 2.4.6.3 System shall be designed with separating pneumatic or magnetic equipment to keep metal particles from entering into grinding equipment.

- 2.4.6.4 Where a group of grinding or pulverizing mills discharge to a common conveyor or spout each mill shall be isolated by individual rotary valves, feeders or choke section.
- 2.4.7 Dust Collectors
 - 2.4.7.1 Dry dust collectors shall be located outdoors or in separate rooms with explosion venting provisions.
 - 2.4.7.2 Separate collectors shall be provided for different processes.
- 2.4.8 Flowlers and Exhaust Fans
 - 2.4.8.1 Exhaust fans shall be downstream of collectors.
 - 2.4.8.2 Fans and blowers shall have safe clearance between blade and casing.
 - 2.4.8.3 Blades shall be constructed of non-ferrous or other non-sparking material.
 - 2.4.8.4 Dust sealed antifriction bearings shall be used whenever possible.
- 2.5 Housekeeping
 - 2.5.1 The interiors, and enviorns of buildings shall be maintained so that conditions will not be conducive to an explosion.
 - 2.5.2 Blast cleaning of dust by compressed air shall not be permitted.
 - 2.5.3 Vacuum cleaning method shall be used whenever possible.
 - 2.5.4 Soft push brush may be used with care.
- 2.6 Ventilation of Building. Ventilation intake and exhausts shall be as remote from each other as possible. Re-circulation of exhausted air shall not be permitted.
- 2.7 Explosion Relief. Relief devices shall be provided in compliance to paragraph 2.9.
- 2.8 Dust Collection
 - 2.8.1 Dust collection shall be accomplished under negative pressure.
 - 2.8.2 All machinery such as cleaners, scalpers and similar devices not designed to be dust tight shall be provided with air aspiration.
 - 2.8.3 Air aspiration shall be provided on all belt discharges, trippers, distributor heads, and at the end of all belts.
 - 2.8.4 Duct work exposed to dust environment shall be made of non-combustible material.
- 2.9 Electrical and Other Sources of Ignition.
 - 2.9.1 Sources of ignition and hot surfaces shall not be permitted.

- 2.9.2 Gun type tools using powders or cartridges shall not be used in combustible dust environment.
- 2.9.3 Internal combustion engines shall not be used in combustible dust areas.
- 2.9.4 Spontaneous heating shall be avoided.
- 2.9.5 Machinery capable of producing static sparks shall be grounded. or other means shall be used for elimination of all possible sources of sparks.
- 2.9.6 Electrical system and wiring shall be in accordance with Section 7.0 for Class 2 areas.
- 2.9.7 Welding or cutting shall be limited to restricted areas. If it is necessary to do welding or cutting outside these areas, written permission of superintendent or other recognized officer shall be obtained.
- 2.10 General Precautions
 - 2.10.1 Flammable and combustible liquid shall be stored in accordance with related Gulf standard.
 - 2.10.2 There shall be no storage of combustible solid materials, within processing buildings.
 - 2.10.3 All tools used shall be made of non-sparking materials.
- 2.11 Fire Protection. Fire protection equipment shall be provided for extra hazardous area.

3. EXPLOSIVES AND BLASTING AGENTS

3.1 Definitions

Acceptor. High explosives, blasting agents, and ammonium nitrate capable of being detonated by the impact of explosive forces in the proximity.

Blasting Agent. Any material or mixture, consisting of a fuel and oxidizer, intended for blasting, not otherwise classified as an explosive and in which none of the ingredients are classified as an explosive, provided that the finished product, as mixed and packaged for use or shipment, cannot be detonated by means of a test blasting cap when unconfined.

Blasting Cap. A metallic tube closed at one end, containing a charge of one or more detonating compounds, and designed for and capable of detonation from the sparks or flame from a safety fuse inserted and crimped into the open end.

Blockholding. The breaking of boulders by firing a charge of explosives that has been loaded in a drill hole.

Bus Wire. An expendable wire, used in parallel or series, to which are connected the leg wires of electric blasting caps.

Class A Explosives. Possessing detonating, or otherwise maximum hazard qualities, such as dynamite, nitroglycerin, picric acid, lead azide, fulminate of mercury, black powder, blasting caps, and detonating primers.

Class B Explosives. Possessing flammable hazard, such as propellant explosives (including some smokeless propellants), photographic flash powders, and some special fireworks.

Class C Explosives. Includes certain types of manufactured articles which contain Class A or Class B explosives, or both, as components but in restricted quantities.

Collar. The immediate vicinity of the mouth of a shaft.

Connecting Wire. An insulated wire used between the electric blasting caps and the leading wires or between the bus wire and the leading wires.

Detonating Cord. A flexible cord containing a center core of high explosives which when detonated, will have sufficient strength to detonate other cap-sensitive explosives with which it is in contact.

Detonator. Blasting caps, electric blasting caps, delay electric blasting caps, and non-electric delay blasting caps.

Donor. High explosives, blasting agents, and combination of masses of detonating materials.

Electric Blasting Cap. A blasting cap designed for and capable of detonation by means of an electric current.

Electric Delay Blasting Caps. Caps designed to detonate at a predetermined period of time after energy is applied to the ignition system.

Explosive. Any chemical compound, mixture, or device, the primary or common purpose of which is to function by explosion, that is with substantially instantaneous release of gas and heat. The term “explosives” shall include all material which is classified as Class A, Class B, and Class C explosives, and includes, but is not limited to dynamite, black powder, pellet powders, initiating explosives, blasting caps, electric blasting caps, safety fuse, fuse lighters, fuse igniters, squibs, cordeau detonant fuse, instantaneous fuse, igniter cord, igniters, small arms ammunition, small arms ammunition primers, smokeless propellant, cartridges for propellant -actuated power devices, and cartridges for industrial guns. Commercial explosives are those explosives which are intended to be used in commercial or industrial operators.

Explosive-Actuated Power Devices. Any tool or special mechanized device which is actuated by explosives, but not including propellant-actuated power devices. Examples of explosive actuated power devices are jet tappers and jet perforators.

Leading Wire. An insulated wire used between the electric power source and the electric blasting cap circuit.

Magazine. Any building or structure, other than an explosives manufacturing building, used for the storage of explosives.

Misfire. An explosive charge which failed to detonate.

Mud-Capping. (Sometimes known as bulldozing, adobe blasting, or dobying). The blasting of boulders by placing a quantity of explosives against a rock, boulder, or other object without confining the explosives in a drill hole.

Non-electric Delay Blasting Cap. A blasting cap with an integral delay element in conjunction with and capable of being detonated by a detonation impulse or signal from miniaturized detonating cord.

Permanent Blasting Wire. A permanently mounted insulated wire used between the electric power source and the electric blasting cap circuit.

Primary Blasting. The blasting operation by which the original rock formation is dislodged from its natural location.

Primers. Percussion-sensitive explosive charges, encased in a cap, used to ignite propellant powder.

Propellant-Actuated Power Devices. Any tool or special mechanized device or gas generator system which is actuated by a smokeless propellant or which releases and directs work through a smokeless propellant charge.

Pyrotechnics. Any combustible or explosive composition or manufactured articles designed and prepared for the purpose of producing audible or visible effects which are commonly referred to as fireworks.

Safety Fuse. A flexible cord containing an internal burning medium by which fire is conveyed at a continuous and uniform rate for the purpose of firing blasting caps.

Secondary Blasting. The reduction of oversize material by the use of explosives to the dimension required for handling, including mudcapping and blockholing.

Semiconductive Hose. A hose with an electrical resistance high enough to limit flow of stray electric currents to safe levels, yet not so high as to prevent drainage of static electric charges to ground; hose of not more than 2 megohms resistance over its entire length and of not less than 16,400 ohms/m meets the requirements.

Smokeless Propellants. Solid propellants, commonly called smokeless powders in the trade, used in propellant-actuated power devices.

Special Industrial Explosives Devices. Explosive-actuated power devices and propellant-actuated power devices.

Special Industrial Explosives Materials. Shaped materials and sheet forms and various other extrusions, pellets, and packages of high explosives, which include

dynamite, trinitrotoluene (TNT), pentaerythritol tetranitrate (PETN), hexahydro-1,3,5-trinitro-s-triazine (RDX), and other similar compounds used for high-energy-rate forming, expanding, and shaping in metal fabrication. and for dismemberment and quick reduction of scrap metal.

Springing. The creation of a pocket in the bottom of a drill hole by the use of a moderate quantity of explosives in order that larger quantities of explosives may be inserted therein.

Stemming. A suitable inert incombustible material or device used to confine or separate explosives in a drill hole, or to cover explosives in mudcapping.

Water Gels or Slurry Explosives. These comprise a wide variety of materials used for blasting. They all contain substantial proportions of water and high proportions of ammonium nitrate, some of which is in solution in the water. Two broad classes of water gels are those which are sensitized by a material classed as an explosive, such as TNT or smokeless powder, those which contain no ingredient classified as an explosive; these are sensitized with metals such as aluminum or with other fuels. Water gels may be permixed at an explosives plant or mixed at the site immediately before delivery into the borehole.

- 3.2 Miscellaneous Provisions. No person shall store, handle, or transport explosives or blasting agents when such storage, handling, and transportation of explosives or blasting agents constitutes an undue hazard to life and property.
- 3.3 Storage of Explosives
 - 3.3.1 General Provisions
 - 3.3.1.1 All Class A, Class B, Class C explosives, and special industrial explosives, and any newly developed and unclassified explosives, shall be kept in magazines which meet the requirements of this paragraph.
 - 3.3.1.2 Blasting caps, electric blasting caps, detorating primers, and primed cartridges shall not be stored in the same magazine with other explosives.
 - 3.3.1.3 Ground around magazines shall slope away for drainage. The land surrounding magazines shall be kept clear of brush, dried grass, leaves, and other materials for a distance of at least 7.5 m.
 - 3.3.1.4 Magazines as required by this paragraph shall be of two classes; namely Class 1 magazines, and Class 2 magazines. (Ref. subparagraphs 3.3.3 and 3.3.4).
 - 3.3.1.5 Class 1 magazines shall be required where the quantity of explosives stored is more than 22.5 kg. Class 2 magazines may be used where the quantity of explosives stored is 22.5 kg or less.
 - 3.3.1.6 Class 1 magazines shall be located away from other magazines in conformity with Table 4.4-1.
 - 3.3.1.7 Except as provided in subparagraph 3.3.1.8, Class 2 magazines shall be located in conformity with subparagraph 3.3.1.6, but may be permitted in warehouses and in

wholesale and retail establishments when located on a floor which has an entrance at outside grade level and the magazine is located not more than 3 m from such an entrance. Two Class 2 magazines may be located in the same building when one is used only for blasting caps in quantities not in excess of 5,000 caps and a distance of 3 m is maintained between magazines.

- 4.4.3.1.8 Class 2 magazines shall be located away from other magazines when used for temporary storage at a site for blasting operations. A distance of at least 45 m shall be maintained between Class 2 magazines and the work in progress when the quantity of explosives kept therein is in excess of 11.3 kg, and at least 15 m when the quantity of explosives is 11.3 kg, or less.

Table 3-1

Table of distance for storage of explosives (3)
Distances in Meters When Storage is Barricaded ⁽¹⁾

Kilograms(Not Over)	Inhabited Buildings	Public Highways	Separation of Magazines ⁽²⁾
5	30	11	2.5
10	35	14	3.0
15	38	16	3.5
20	43	17	4.0
25	45	19	4.5
35	52	22	5.0
45	58	23	5.0
55	60	25	5.5
70	65	26	6.0
90	72	29	6.5
115	78	32	7.0
135	83	34	7.5
180	90	37	8.5
225	98	40	8.5
275	105	42	9.5
320	110	45	10.0
365	115	46	10.5
410	120	48	11.0
455	123	49	11.0
550	130	51	12.0
640	138	52	12.5
725	145	54	13.5
820	150	55	13.5
910	155	57	14.
1150	170	58	15.
1400	180	60	16.
1800	195	65	18.
2300	210	70	19.
2800	225	73	20.
3200	235	75	21.
3700	245	77	22.
4100	255	78	23.
4600	265	80	24.
5500	270	83	25.
6400	270	85	27.
7300	275	86	28.
8200	280	87	29.
9100	290	90	30.
11400	300	97	33.
14000	325	105	35.
16000	350	110	37.
18000	370	117	38.

Table 3-1 (Continued)

Distances in Meters When Storage is Barricaded ⁽¹⁾

Kilograms(Not Over)	Inhabited Buildings	Public Highways	Separation of Magazines ⁽²⁾
20000	390	123	40.
23000	410	130	42.
25000	430	135	43.
28000	465	140	45.
30000	480	145	47.
32000	495	148	48.
34000	510	153	49.
37000	520	156	51.
39000	530	159	52.
41000	540	162	54.
43000	550	165	55.
46000	555	167	57.
50000	560	168	60.
55000	570	170	63.
59000	575	171	66.
64000	580	173	69.
69000	585	174	72.
73000	590	177	75.
78000	600	180	78.
82000	610	183	81.
87000	615	185	84.
91000	620	186	87.
96000	630	190	90.
105000	645	195	97.
114000	660	200	103.
125000	680	205	110.
137000	695	215	118.

Notes applying to Table 3-1.

Note 1. *“Barricaded” means that a building containing explosives is effectually screened from a magazine, building, railway, or highway, either by a natural barricade, or by an artificial barricade of such height that a straight line from the top of any sidewall of the building containing explosives, to the eave line of any magazine, or building, or to a point 3.7 m above the center of a railway or highway, will pass through such intervening natural or artificial barricade.*

“Natural barricade” means natural features of the ground, such as hills, or timber of sufficient density that the surrounding exposures which require protection cannot be seen from the magazine when the trees are bare of leaves.

“Artificial barricade” means an artificial mound or revetted wall of earth of a minimum thickness of 90 cm.

Note 2. *When two or more storage magazines are located on the same property, each magazine must comply with the minimum distances specified. They should be separated from each other by not less than the distances per the above table, except that the quantity of explosives contained in cap magazines shall govern in regard to the spacing of said cap magazines from magazines containing other explosives. If any two or more magazines are separated from each other by less than the specified distances, then such two or more magazines, as a group, must be considered as one magazine, and the total quantity of explosives stored in such group must be treated as if stored in a single magazine located on the site of any magazine of the group, and must comply with the minimum of distances specified from other magazines, inhabited buildings, railways, and highways.*

Note 3. *This table applies only to the manufacture and permanent storage of commercial explosives. It is not applicable to transportation of explosives, or any handling or temporary storage necessary or incident thereto. It is not intended to apply to bombs, projectiles, or other heavily encased explosives.*

Note 4. *When a building containing explosives is not barricaded, the distances shown in the table shall be doubled.*

3.3.1.9 This section does not apply to:

Stocks of small arms ammunition, propellant-actuated power cartridges, small arms ammunition primers in quantities of less than 750,000, or of smokeless propellants in quantities less than 340 kg.

Explosive-actuated power devices when in quantities less than 22.5 kg net weight of explosives;

Fuse lighters and fuse igniters;

Safety fuses other than cordeau detonant fuses.

3.3.2 Construction of Magazines - General

3.3.2.1 Magazines shall be constructed in conformity with the provisions of this subparagraph.

- 3.3.2.2 Magazines for the storage of explosives, other than black powder, Class B and Class C explosives shall be bullet resistant, whether resistant, fire resistant, and ventilated to protect the explosive. Magazines used only for storage of black powder, Class B and Class C explosives shall be weather resistant, fire-resistant, and have ventilation. Magazines for storage of blasting and electric blasting caps shall be weather resistant, fire-resistant, and ventilated.
- 3.3.2.3 Property upon which Class 1 magazines are located and property where Class 2 magazines are located outside of buildings shall be posted with signs reading "Explosives - Keep Off". Such signs shall be located so as to minimize the possibility of a bullet traveling in the direction of the magazine if anyone shoots at the sign.
- 3.3.2.4 Explosives shall not be permitted to freeze nor stored over 29°C. Magazines requiring heat shall be heated by either hot-water radiant heating within the magazine building; or air directed into the magazine building over either hot water or low pressure steam 1 kg/sq cm coils located outside the building. Cooling shall be by air directed into the magazine building over refrigerant coils located outside the building.
- 3.3.2.5 The magazine heating and/or cooling systems shall meet the following requirements:
- 3.3.2.5.1 Any radiant heating coils within the building shall be installed in such a manner that the explosives or explosives containers cannot contact the coils and air is free to circulate between the coils and the explosives or explosives containers.
- 3.3.2.5.2 The air ducts shall be installed in such a manner that the air discharge from the duct is not directed against the explosives or explosives containers.
- 3.3.2.5.3 The electric fan, compressor or pump used in the heating or cooling system shall be mounted outside and separate from the wall of the magazine and shall be grounded.
- 3.3.2.5.4 Electric motors and the controls for electrical devices used shall have overloads and disconnects, which comply with Section 7.0. All electrical switch gear shall be located a minimum distance of 7.5 m from the magazine.
- 3.3.2.5.5 The heating or cooling source shall be separated from the magazine by a distance of not less than 7.5 m when electrical and 15 m when fuel fired. The area between the heating and/or cooling unit and the magazine shall be cleared of all combustible materials.
- 3.3.2.5.6 The storage of explosives and explosives containers in the magazine shall allow uniform air circulation so product temperature uniformity can be maintained.
- 3.3.2.6 When lights are necessary inside the magazine, electric explosion-proof flashlight, or electric explosion-proof lanterns shall be used.
- 3.3.2.7 Lighting protection shall be provided for all magazines.
- 3.3.3 Construction of Class 1 Magazines

- 3.3.3.1 Class 1 magazines shall be of masonry, wood or metal construction, or a combination of these types. Thickness of masonry units shall not be less than 20 cm. Hollow masonry units used in construction required to be bullet resistant shall have all hollow spaces filled with weak cement or well-tamped sand. Wood constructed walls, required to be bullet resistant, shall have at least a 15 cm space between interior and exterior sheathing and the space between sheathing shall be filled with well-tamped sand. Metal wall construction, when required to be bullet resistant, shall be lined with brick at least 10 cm in thickness or shall have at least 15 cm sandfill between interior and exterior walls.
- 3.3.3.2 Floors and roofs of masonry magazines may be of wood construction. Wood floors shall be tongue and grooved lumber having a nominal thickness of 26 cm.
- 3.3.3.3 Roofs required to be bullet resistant shall be protected by sand tray located at the line of eaves and covering the entire area except that necessary for ventilation. Sand in the sand tray shall be maintained at a depth of not less than 10 cm.
- 3.3.3.4 All wood at the exterior of magazines, including eaves, shall be protected by being covered with black or galvanized steel or aluminum metal of thickness of not less than 0.5 m. All nails exposed to the interior of magazines shall be well countersunk.
- 3.3.3.5 Magazines shall be ventilated sufficiently to prevent dampness and heating of stored explosives. Ventilating openings shall be screened to prevent the entrance of sparks.
- 3.3.3.6 Openings to magazines shall be restricted to those necessary for the placement and removal of stocks of explosives. Doors for openings in magazines for Class A explosives shall be bullet resistant. Doors for magazines not required to be bullet resistant shall be designed to prevent unauthorized entrance to the magazine.
- 3.3.3.7 Provisions shall be made to prevent the piling of stocks of explosives directly against masonry walls, brick-lined or sand filled metal walls and single-thickness metal walls; such piling, however, shall not interfere with proper ventilation at the interior of side and end walls,
- 3.3.3.8 Magazines shall be painted red and shall bear lettering in white, on all sides and top, at least 75 cm high, "Explosives - Keep Fire Away".
- 3.3.4 Construction of Class 2 Magazines
- 3.3.4.1 Class 2 magazines shall be of wood or metal construction, or a combination thereof,
- 3.3.4.2 Wood magazines of this class shall have sides, bottom, and cover constructed of 5 cm hardwood boards well braced at corners and protected by being entirely covered with sheet metal of not less than 1 mm. All nails exposed to the interior of the magazine shall be well countersunk. All metal magazines of this class shall have sides, bottom, and cover constructed of sheet metal, and shall be lined with plywood or equivalent. Edges of metal covers shall overlap sides at least 25 mm.

- 3.3.4.3 Covers for both wood and metal-constructed magazines of this class shall be provided with strap hinges and shall be provided with means for locking.
- 3.3.4.4 Magazines shall be painted red and shall bear lettering in white, on all sides and top, at least 75 cm high, "Explosives - Keep Fire Away". Class 2 magazines when located in warehouses, and in wholesale and retail establishments shall be provided with wheels or castors to facilitate easy removal in the case of fire. Class 2 magazines shall be ventilated.
- 3.3.5 Storage Within Magazines
- 3.3.5.1 Packages of explosives shall be laid flat with top side up. Black powder when stored in magazines with other explosives shall be stored separately. Black powder stored in kegs shall be stored on ends, bungs down, or on side, seams down. Corresponding grades and brands shall be stored together in such a manner that brands and grade marks show. All stocks shall be stored so as to be easily counted and checked. Packages of explosives shall be piled in a stable manner. When any kind of explosive is removed from a magazine for use, the oldest explosive of that particular kind shall always be taken.
- 3.3.5.2 Packages of explosives shall not be unpacked or repacked in a magazine nor within 15 m of a magazine or in close proximity to other explosives. Tools used for opening packages of explosives shall be constructed of nonsparking materials, nonsparking metallic slitters may be used for opening fiberboard boxes. A wood wedge and a fiber, rubber, or wood mallet shall be used for opening or closing wood packages of explosives. Opened packages of explosives shall be securely closed before being returned to a magazine.
- 3.3.5.3 Magazines shall not be used for the storage of any metal tools nor any commodity except explosives, blasting agents and blasting supplies.
- 3.3.5.4 Magazine floors shall be regularly swept, kept clean, dry, free of grit, paper, empty used packages, and rubbish. Brooms and other cleaning utensils shall have no spark-producing metal parts. Sweepings from floors of magazines shall be properly disposed of. Magazine floors stained with nitroglycerin shall be cleaned according to instructions by the manufacturer.
- 3.3.5.5 When any explosive has deteriorated to an extent that it is in an unstable or dangerous condition, or if nitroglycerin leaks from any explosives, then the person in possession of such explosive shall immediately proceed to destroy such explosive in accordance with the instructions of the manufacturer. Only experienced persons shall be allowed to do the work of destroying explosives.
- 3.3.5.6 When magazines need inside repairs, all explosives shall be removed therefrom and the floors cleaned. In making outside repairs, if there is a possibility of causing sparks or fire the explosives shall be removed from the magazine. Explosives removed from a magazine under repair shall either be placed in another magazine or placed a safe distance from the magazine where they shall be properly guarded and protected until repairs have been completed.

- 3.3.5.7 Smoking, matches, open flames, spark-producing devices, and firearms (except firearms carried by guards) shall not be permitted inside of or within 15 m of magazines. The land surrounding a magazine shall be kept clear of all combustible materials for a distance of at least 7.5 m. Combustible materials shall not be stored within 15 m of magazines.
- 3.3.5.8 Magazines shall be in the charge of a competent person at all times who shall be held responsible for the enforcement of all safety precautions.
- 3.3.5.9 Explosives recovered from blasting misfires shall be placed in a separate magazine until competent personnel have determined from the manufacturer the method of disposal. Caps recovered from blasting misfires shall not be reused. Such caps shall then be disposed of in the manner recommended by the manufacturer.
- 3.4 Transportation of Explosives
 - 3.4.1 General Provisions
 - 3.4.1.1 No employee shall be allowed to smoke, carry matches or any other flame-producing device, or carry any firearms or loaded cartridges while in or near a motor vehicle transporting explosives; or drive, load, or unload such vehicle in a careless or reckless manner.
 - 3.4.1.2 Explosives shall not be transferred from one vehicle to another within the confines of any jurisdiction without informing the fire and police departments thereof. In the event of breakdown or collision the local fire and police departments shall be promptly notified to help safeguard such emergencies. Explosives shall be transferred from the disabled vehicle to another only when proper and qualified supervision is provided.
 - 3.4.1.3 Blasting caps or electric blasting caps shall not be transported over the highways on the same vehicles with other explosives.
 - 3.4.2 Transportation Vehicles
 - 3.4.2.1 Vehicles used for transporting explosives shall be strong enough to carry the load without difficulty and be in good mechanical condition. If vehicles do not have a closed body, the body shall be covered with a flameproof and moisture-proof tarpaulin or other effective protection against moisture and sparks. All vehicles used for the transportation of explosives shall have tight floors and any exposed spark-producing metal on the inside of the body shall be covered with wood or other non-sparking materials to prevent contact with packages of explosives. Packages of explosives shall not be loaded above the sides of an open-body vehicle.
 - 3.4.2.2 Every vehicle used for transporting explosives and oxidizing materials shall be marked as follows:
 - 3.4.2.2.1 Exterior markings or placards required on applicable vehicles shall be as follows for the various classes of commodities:

Commodity	Type of marking or placard
Explosives, Class A or B, any quantity or a combination of Class A and B explosives.	Explosives (Red letters on white background).
Oxidizing material (blasting agents, ammonium nitrate etc.), 450. Kg or more gross weight.	Oxidizers (Yellow letters on black background).

- 3.4.2.2.2 Such markings or placards shall be displayed at the front, rear, and on each side of the motor vehicle or trailer, or other cargo carrying body while it contains explosives or oxidizing materials. The front marking or placard may be displayed on the front of either the truck, truck body, truck tractor or the trailer.
- 3.4.2.2.3 Any motor vehicle, trailer, or other cargo-carrying body containing more than one kind of explosive as well as an oxidizing material requiring a placard, the aggregate gross weight of which totals 450. Kg or more, shall be marked or placarded "Dangerous" as well as "Explosive".
- 3.4.2.2.4 In any combination of two or more vehicles containing explosives or other dangerous articles each vehicle shall be marked or placarded as to its contents.
- 3.4.2.3 Each motor vehicle used for transporting explosives shall be equipped with a minimum of two extinguishers. Only approved extinguishers shall be used on explosives-carrying vehicles. Extinguishers shall be ready for immediate use and located near the driver's seat. Extinguishers shall be examined periodically by a competent person.
- 3.4.2.4 A motor vehicle used for transporting explosives shall be given the following inspection to determine that it is in proper condition for safe transportation of explosives:
- 3.4.2.4.1 Fire extinguishers shall be filled and in working order.
- 3.4.2.4.2 All electrical wiring shall be completely protected and securely fastened to prevent short circuiting.
- 3.4.2.4.3 Chassis, motor, pan, and underside of body shall be reasonably clean and free of excess oil and grease.
- 3.4.2.4.4 Fuel tank and feedline shall be secure and have no leaks.
- 3.4.2.4.5 Brakes, lights, horn, windshield wipers, and steering apparatus shall function properly.

- 3.4.2.4.6 Tires shall be checked for proper inflation and defects.
- 3.4.2.4.7 The vehicle shall be in proper condition in every other respect and acceptable for handling explosives.
- 3.4.3 Operation of Transportation Vehicles
 - 3.4.3.1 Vehicles transporting explosives shall only be driven by and be in the charge of a driver who is familiar with the traffic regulations, and the provisions of this section.
 - 3.4.3.2 Except under emergency conditions, no vehicle transporting explosives shall be parked before reaching its destination, even though attended, on any public street adjacent to or in proximity to any place where people work, congregate, or assemble, or dwell-
 - 3.4.3.3 Every motor vehicle transporting any quantity of Class A or Class B explosives shall, at all times, be attended by a driver or other attendant of the motor carrier.
 - 3.4.3.3.1 This attendant shall have been made aware of the class of the explosive material in the vehicle and of its inherent dangers, and shall have been instructed in the measures and procedures to be followed in order to protect the public from those dangers. He shall have been made familiar with the vehicle he is assigned, and shall be trained, and authorized to move the vehicle when required.
 - 3.4.3.3.2 A motor vehicle shall be deemed “attended” only when the driver or other attendant is physically on or in the vehicle, or has the vehicle within his field of vision and can reach it quickly without any kind of interference; “attended” also means that the driver or attendant is awake, alert, and not engaged in other duties or activities which may divert his attention from the vehicle, except for necessary communication with public officers, or representatives of the carrier, shipper, or consignee.
 - 3.4.3.3.3 However, an explosive-laden vehicle may be left unattended if parked within a securely fenced or walled area with all gates or entrances locked where parking of such vehicle is permissible, or at a magazine site established solely for the purpose of strong explosives.
 - 3.4.3.4 No spark-producing metal, spark-producing metal tools, oils, matches, firearms, electric storage batteries, flammable substances, acids, oxidizing materials, or corrosive compounds shall be carried in the body of any motor truck and/or vehicle transporting explosives.
 - 3.4.3.5 Vehicles transporting explosives shall avoid congested areas and heavy traffic. Where routes through congested areas have been designated by local authorities such routes shall be followed.
 - 3.4.3.6 Delivery shall only be made to authorized persons and into authorized magazines or authorized temporary storage or handling, areas.
- 3.4.5 Use of Explosives and Blasting Agents

3.4.5.1 General Provisions**3.4.5.1.1 The employer shall permit only authorized and qualified persons to handle and use explosives.**

While explosives are being handled or used, smoking shall not be permitted and no one near the explosives shall possess matches, open light or other fire or flame. No person shall be allowed to handle explosives while under the influence of intoxicating liquors, narcotics, or other dangerous drugs.

3.4.5.1.2 Original containers or Class 2 magazines shall be used for taking detonators and other explosives from storage magazines to the blasting area.**3.4.5.1.3 All explosives shall be accounted for at all times. Explosives not being used shall be kept in a locked magazine, unavailable to persons not authorized to handle them. The employer shall maintain an inventory and use record of all explosives. Appropriate authorities shall be notified of any loss, theft, or unauthorized entry into a magazine.****3.4.5.1.4 No explosives, blasting agents, detonating cord or detonators (blasting caps) of any type shall be abandoned.****3.4.5.1.5 When blasting is done in congested areas or in proximity to structure, railway, highway, or any other installation that may be damaged, the blaster shall take special precautions in the loading, delaying, initiation, and confinement of each blast with mats or other methods so as to control the throw of fragments, and thus prevent bodily injury to employees.****3.4.5.1.6 Employees authorized to prepare explosive charges or conduct blasting operations shall use every reasonable precaution including, but not limited to, visual and audible warning signals, flags, or barricades, or woven wire mats to ensure employee safety.****3.4.5.1.7 Insofar as possible, blasting operations above ground shall be conducted between sunup and sundown.****3.4.5.1.8 Due precautions shall be taken to prevent accidental discharge of electric blasting caps from current induced by radar, radio transmitters, lightning, adjacent powerlines, dust storms, or other sources of extraneous electricity. These precautions shall include:****3.5.1.8.1 Detonators shall be short-circuited in holes which have been primed and shunted until wired into the blasting circuit.****3.5.1.8.2 The suspension of all blasting operations and removal of persons from the blasting area during the approach and progress of an electric storm.****3.5.1.8.3 The prominent display of adequate signs, warning against the use of mobile radio transmitters, on all roads within 300 m of blasting operations. Whenever adherence to the 300 m distance would create an operational handicap, a competent person shall be consulted to evaluate the particular situation, and alternative provisions may be made which are adequately designed to prevent any**

premature firing of electric blasting caps. A description of any such alternatives shall be reduced to writing and shall be certified as meeting the purposes of this subparagraph by the competent person consulted. The description shall be maintained at the construction site during the duration of the work, and shall be available for inspection by concerned authorities.

- 3.5.1.9 Whenever blasting is being conducted in the vicinity of gas, electric, water, sewage lines, fire alarm, telephone, telegraph, and steam utilities, the blaster shall notify the appropriate representatives of such utilities at least 24 hours in advance of blasting, specifying the location and intended time of such blasting. Verbal notice shall be confirmed with written notice.
- 3.4.5.2 Storage at Use Sites
 - 3.4.5.2.1 Empty boxes, paper and fiber packing materials which have previously contained high explosives shall not be used again for any purpose, but shall be destroyed by burning at an approved isolated location out of doors, and no persons shall be nearer than 30 m after the burning has started.
 - 3.4.5.2.2 Containers of explosives shall not be opened in any magazine or within 15 m of any magazine. In opening kegs or wooden cases, no sparking metal tools shall be used; wooden wedges and either wood, fiber or rubber mallets shall be used. Nonsparking metallic slitters may be used for opening fiberboard cases.
 - 3.4.5.2.3 Explosives or blasting equipment that are obviously deteriorated or damaged shall not be used.
- 3.4.5.3 Blaster Qualifications
 - 3.4.5.3.1 A blaster shall be able to understand and give written and oral orders.
 - 3.4.5.3.2 A blaster shall be qualified, by reason of training, knowledge, or experience, in the field of transporting, storage, handling and use of explosives, and have a working knowledge of laws and regulations which pertain to explosives.
 - 3.4.5.3.3 Blasters shall be required to furnish satisfactory evidence of competency in handling explosives and performing in a safe manner the type of blasting that will be required.
 - 3.4.5.3.4 The blaster shall be knowledgeable and competent in the use of each type of blasting method used.
- 3.4.5.4 Loading of Explosives in Blast Holes
 - 3.4.5.4.1 No explosives or blasting agents shall be left unattended at the blast site.
 - 3.4.5.4.2 Machines and all tools not used for loading explosives into bore holes shall be removed from the immediate location of holes before explosives are delivered. Equipment shall not be operated within 15 m of loaded holes.
 - 3.4.5.4.3 No activity of any nature other than that which is required for loading holes with explosives shall be permitted in a blast area.

- 3.4.5.4.4 All drill holes shall be sufficiently large to admit freely the insertion of the cartridges of explosives.
- 3.4.5.4.5 Tamping shall be done only with wood rods without exposed metal parts, but nonsparking metal connectors may be used for jointed poles. Violent tamping shall be avoided. Primed cartridges shall not be tamped.
- 3.4.5.4.6 When loading blasting agents pneumatically over electric blasting caps, semiconductive delivery hose shall be used and the equipment shall be bonded and grounded.
- 3.4.5.4.7 No holes shall be loaded except those to be fired in the next round of blasting. After loading, all remaining explosives shall be immediately returned to an authorized magazine.
- 3.4.5.4.8 Drilling shall not be started until all remaining bits of old holes are examined with a wooden stick for unexploded charges, and if any are found, they shall be refired before work proceeds.
- 3.4.5.4.9 No loaded holes shall be left unattended or unprotected.
- 3.4.5.4.10 No person shall be allowed to deepen drill holes which have contained explosives.
- 3.4.5.4.11 After loading for a blast is completed, all excess blasting caps or electric blasting caps and other explosives shall immediately be returned to their separate storage magazines.
- 3.4.5.4.12 The blaster shall keep an accurate, up-to-date record of explosives, blasting agents, and blasting supplies used in a blast and shall keep an accurate running inventory of all explosives and blasting agents stored on the operation.
- 3.4.5.5 Initiation of Explosive Charges
 - 3.4.5.5.1 The use of fuses is prohibited unless electric blasting caps can not be used (See paragraph 3.4.12).
 - 3.4.5.5.2 When a fuse is used, the blasting cap shall be securely attached to the safety fuse with a cap crimper. All primers shall be assembled at least 15 m from any magazine.
 - 3.4.5.5.3 Primers shall be made up only as required for each round of blasting.
 - 3.4.5.5.4 No blasting cap shall be inserted in the explosives without first making a hole in the cartridge for the cap with a wooden punch of proper size or standard cap crimper.
 - 3.4.5.5.5 Explosives shall not be extracted from a hole that has once been charged or has misfired unless it is impossible to detonate the unexploded charge by insertion of a fresh additional primer.
 - 3.4.5.5.6 If there are any misfires while using cap and fuse, all persons shall be required to remain away from the charge for at least 1 hour. If electric blasting caps are used and a misfire occurs, this waiting period may be reduced to 30 minutes. Misfires

shall be handled under the direction of the person in charge of the blasting and all wires shall be carefully traced and search made for unexploded charges.

- 3.4.5.5.7 Blasters, when testing circuits to charged holes, shall use only blasting galvanometers designed for this purpose.
- 3.4.5.5.8 Only the blaster firing the shot shall make leading wire connections in electrical firing shall be allowed to fire the shot. Leading wires shall remain shorted and not be connected to the blasting machine or other source of current until the charge is to be fired.
- 3.4.5.6 Warning Required. Before a blast is fired, the employer shall require loud warning signals be given (See Table 3.4-3) by the person in charge, who has made certain that all surplus explosives are in a safe place, all persons and vehicles are at a safe distance or under sufficient cover, and that an adequate warning has been given.
- 3.4.6 Blasting Agents
 - 3.4.6.1 General. Unless otherwise set forth in this paragraph, blasting agents, excluding water gels, shall be transported, stored, and used in the same manner as explosives. Water gels are covered in paragraph 3.4.7.
 - 3.4.6.2 Fixed Location Mixing
 - 3.4.6.2.1 Buildings used for the mixing of blasting agents shall conform to the requirements of this paragraph.
 - 3.4.6.2.1.1 Buildings shall be of noncombustible construction or sheet metal on wood studs.
 - 3.4.6.2.1.2 Floors in a mixing plant shall be of concrete or of other nonabsorbent materials.
 - 3.4.6.2.1.3 All fuel oil storage facilities shall be separated from the mixing plant and located in such a manner that in case of tank rupture, the oil will drain away from the mixing plant building.
 - 3.4.6.2.1.4 The building shall be ventilated.
 - 3.4.6.2.2 Heating units which do not depend on combustion processes, when properly designed and located, may be used in the building. All direct sources of heat shall be provided exclusively from units located outside the mixing building.
 - 3.4.6.2.3 All internal-combustion engines used for electric power generation shall be located outside the mixing plant building, or shall be properly ventilated and isolated by a firewall. The exhaust systems on all such engines shall be fitted with approved, efficient spark arresters and shall also be located so any spark emission cannot be a hazard to any materials in, or adjacent to the plant.
 - 3.4.6.2.4 Equipment used for mixing blasting agents shall conform to the requirements of this subparagraph.
 - 3.4.6.2.4.1 The design of the mixer shall minimize the possibility of frictional heating, compaction, and especially confinement. All bearings and drive assemblies shall be mounted outside the mixer and protected against the accumulation of dust.

- 3.4.6.2.4.2 All surfaces shall be accessible for cleaning.
- 3.4.6.2.4.3 Mixing and packaging equipment shall be constructed of materials compatible with the fuel-ammonium nitrate composition.
- 3.4.6.2.4.4 Suitable means shall be provided to prevent the flow of fuel oil to the mixer in case of fire. In gravity flow systems an automatic spring-loaded shutoff valve with fusible link shall be installed at the tank outlet.
- 3.4.6.2.5 The provisions of the subparagraph shall be considered when determining blasting agent compositions.
 - 3.4.6.2.5.1 The sensitivity of the blasting agent shall be determined by means of a No. 8 test blasting cap at regular intervals and after every change in formulation.
 - 3.4.6.2.5.2 Oxidizers of small particle size, such as crushed ammonium nitrate prills or fines, may be more sensitive than coarser products and shall, therefore, be handled with greater care.
 - 3.4.6.2.5.3 No hydrocarbon liquid fuel with Flashpoint lower than that of 52°C minimum shall be used.
 - 3.4.6.2.5.4 Crude oil and crankcase oil shall not be used.
 - 3.4.6.2.5.5 Metal powders such as aluminum shall be kept dry and shall be stored in containers or bins which are moisture-resistant or weathertight.
 - 3.4.6.2.5.6 Solid fuels shall be used in such manner as to minimize dust explosion hazards.
 - 3.4.6.2.5.7 Peroxides and chlorates shall not be used.
- 3.4.6.2.6 All electrical switches, controls, motors, and lights located in the mixing room shall conform to the requirements in Section 7.0 for Class 2, Division 2 locations; otherwise they shall be located outside the mixing room. All metal parts of each mixer, and associated machinery, must be electrically bounded together and shall be connected to a suitable independent ground.
- 3.4.6.2.7 Safety precautions at mixing plants shall include the following requirements:
 - 3.4.6.2.7.1 Floors shall be constructed to as to eliminate floor drains and piping into which molten materials could flow and be confined in case of fire.
 - 3.4.6.2.7.2 The floors and equipment of the mixing and packaging room shall be cleaned regularly and thoroughly to prevent accumulation of oxidizers or fuels and other sensitizers.
 - 3.4.6.2.7.3 The entire mixing and packaging plant shall be cleaned regularly and thoroughly to prevent excessive accumulation of dust.
 - 3.4.6.2.7.4 Smoking, matches, open flames, spark-producing devices, and firearms (except firearms carried by guards) shall not be permitted inside of or within 15 m of any building or facility used for the mixing of blasting agents.

- 3.4.6.2.7.5 The land surrounding the mixing plant shall be kept clear of brush, dried grass, leaves, and other materials for a distance of at least 15 m. Empty ammonium nitrate bags shall be disposed of daily in a safe manner.
- 3.4.6.2.7.6 No welding shall be permitted or open flames used in or around the mixing or storage area of the plant unless the equipment or area has been completely washed down and all oxidizer material removed.
- 3.4.6.2.7.7 Before welding or repairs to hollow shafts, all oxidizer material shall be removed from the outside and inside of the shaft and the shaft vented with a minimum 13 mm diameter opening.
- 3.4.6.2.7.8 Explosives shall not be permitted inside of or within 15 m of any building or facility used for the mixing of blasting agents.
- 3.4.6.3 Bulk Delivery and Mixing Vehicles
 - 3.4.6.3.1 The provisions of this subparagraph shall apply to off-highway private operations as well as to all public highway movements.
 - 3.4.6.3.2 A bulk vehicle body for delivering and mixing blasting agents shall conform with the following requirements:
 - 3.4.6.3.2.1 The body shall be constructed of noncombustible materials.
 - 3.4.6.3.2.2 Vehicles used to transport bulk premixed blasting agents shall have closed bodies.
 - 3.4.6.3.2.3 All moving parts of the mixing system shall be designed so as to prevent a heat buildup. Shafts or axles which contact the product shall have outboard bearings with 25 mm minimum clearance between the bearings and the outside of the product container. Particular attention shall be given to the clearances on all moving parts.
 - 3.4.6.3.2.4 A bulk delivery vehicle shall be strong enough to carry the load without difficulty and be in good mechanical condition. (See subparagraph 3.4.4.2).
 - 3.4.6.3.2.5 A positive action parking brake which will set the wheel brakes on at least one axle shall be provided on vehicles when equipped with air brakes and shall be used during bulk delivery operations. Wheel chocks shall supplement parking brakes whenever conditions may require.
 - 3.4.6.3.3 Operation of bulk delivery vehicles shall conform to the following requirements:
 - 3.4.6.3.3.1 The operator shall be trained in the safe operation of the vehicle together with its mixing, conveying, and related equipment. The employer shall assure that the operator is familiar with the commodities being delivered and the general procedure for handling emergency situations.
 - 3.4.6.3.3.2 The hauling of either blasting caps or other explosives, but not both, shall be permitted on bulk trucks provided that a special wood or nonferrous-lined container is installed in which they will be carried.

- 3.4.6.3.3.3 No person shall smoke, carry matches or any flame-producing device, or carry any firearms while in or about bulk vehicles effecting the mixing transfer or down-the-hole loading of blasting agents at or near the blasting site.
- 3.4.6.3.3.4 Caution shall be exercised in the movement of the vehicle in the blasting area to avoid driving the vehicle over or dragging hoses over firing lines, cap wires, or explosive materials. The employer shall assure that the driver, in moving the vehicle, has assistance of a second person to guide his movements.
- 3.4.6.3.3.5 No intransit mixing of materials shall be performed.
- 3.4.6.3.4 Pneumatic loading from bulk delivery vehicles into blastholes primed with electric blasting caps or other static-sensitive systems shall conform to the following requirements:
 - 3.4.6.3.4.1 A positive grounding device shall be used to prevent the accumulation of static electricity.
 - 3.4.6.3.4.2 A discharge hose shall be used that has a resistance range that will prevent conducting stray currents, but that is conductive enough to bleed off static buildup.
 - 3.4.6.3.4.3 A qualified person shall evaluate all systems to determine if they will adequately dissipate static under potential field conditions.
- 3.4.6.3.5 Repairs to bulk delivery vehicles shall conform to the requirements of this subparagraph.
 - 3.4.6.3.5.1 No welding or open flames shall be used on or around any part of the delivery equipment unless it has been completely washed down and all oxidizer material removed.
 - 3.4.6.3.5.2 Before welding or making repairs to hollow shafts, the shaft shall be thoroughly cleaned inside and out and vented with a minimum of 13 mm diameter opening.
- 3.4.6.4 Bulk Storage Bins
 - 3.4.6.4.1 The bin, including supports, shall be constructed of compatible materials, waterproof, and be adequately supported and braced to withstand the combination of all loads including impact forces.
 - 3.4.6.4.2 The bin discharge gate shall be designed to provide a closure tight enough to prevent leakage of the stored product. Provision shall be made to lock the gate when not in use.
 - 3.4.6.4.3 Bin loading manways or access hatches shall be designed to permit locking.
 - 3.4.6.4.4 Any electrically driven conveyors for loading or unloading bins shall conform to the requirements of Section 7.0. They shall be designed to minimize damage from corrosion.

- 3.4.6.4.5 Bins containing blasting agent shall be located in accordance with subparagraph 3.3.1.6; separation from other blasting agent storage and explosives storage shall be in conformity with Table 4.4-2.
- 3.4.6.4.6 Bins containing ammonium nitrate shall be separated from blasting agent storage and explosives storage in conformity with Table 3.4-2.
- 3.4.6.5 Storage of Blasting Agents and Supplies
- 3.4.6.5.1 Blasting agents and oxidizers used for mixing of blasting agents shall be stored in the manner set forth in this subparagraph.
- 3.4.6.5.1.1 Blasting agents or ammonium nitrate, when stored in conjunction with explosives, shall be stored in the manner set forth in paragraph 3.4.3 for explosives. The mass of blasting agents and one-half the mass of ammonium nitrate shall be included when computing the total quantity of explosives for determining distance requirements.
- 3.4.6.5.1.2 Blasting agents, when stored entirely separate from explosives, may be stored in the manner set forth in paragraph 3.4.3 or in one-story warehouses (without basements) which shall be:
- Noncombustible or fire resistive;
 - Constructed so as to eliminate open floor drains and piping into which molten materials could flow and be confined in case of fire;
 - Weather resistant;
 - Lightning protected;
 - Well ventilated; and
 - Equipped with a strong door kept securely locked except when open for business.
- 3.4.6.5.1.3 Semitrailer or full-trailer vans used for highway or on site transportation of the blasting agents are satisfactory for temporarily storing these materials, provided they are located in accordance with Table 3.4-2 with respect to one another. Trailers shall be provided with means for locking, and the trailer doors shall be kept locked, except during the time of placement and removal of stocks of blasting agents.
- 3.4.6.5.2 Warehouses used for the storage of blasting agents separate from explosives shall be located as set forth in this subparagraph.
- 3.4.6.5.2.1 Warehouses used for the storage of blasting agents shall be located in accordance with Table 3.4-2 with respect to one another.
- 3.4.6.5.2.2 If both blasting agents and ammonium nitrate are handled or stored within the distance limitations prescribed through subparagraph 3.4.6.2, one-half the mass of the ammonium nitrate shall be added to the mass of the blasting agent when computing the total quantity of explosives for determining the proper distance for compliance with Table 3.4-1.

- 3.4.6.5.3 Smoking, matches, open flames, spark producing devices, and firearms are prohibited inside of or within 15 m of any warehouse used for the storage of blasting agents. Combustible materials shall not be stored within 15 m of warehouses used for the storage of blasting agents.
- 3.4.6.5.4 The interior of warehouses used for the storage of blasting agents shall be kept clean and free from debris and empty containers. Spilled materials shall be cleaned up promptly and safely removed. Combustible materials, flammable liquids, corrosive acids, chlorates, or nitrates shall not be stored in any warehouse used for blasting agents unless separated therefrom by a fire resistive separation of not less than one hour resistance. The provisions of this subparagraph shall not prohibit the storage of blasting agents together with nonexplosive blasting supplies.
- 3.4.6.5.5 Piles of ammonium nitrate and warehouses containing ammonium nitrate shall be adequately separated from readily combustible fuels.
- 3.4.6.5.6 Caked oxidizers, either in bags or in bulk, shall not be loosened by blasting.
- 3.4.6.5.7 Every warehouse used for the storage of blasting agents shall be under the supervision of a competent person.
- 3.4.6.6 Transportation of Packaged Blasting Agents
 - 3.4.6.6.1 When blasting agents are transported in the same vehicle with explosives, all of the requirements of paragraph 3.4.4 shall be complied with.
 - 3.4.6.6.2 No matches, firearms, acids, or other corrosive liquids shall be carried in the bed or body of any vehicle containing blasting agents.
 - 3.4.6.6.3 No person shall be permitted to ride upon, drive, load, or unload a vehicle containing blasting agents while smoking or under the influence of intoxicants, narcotics, or other dangerous drugs.
 - 3.4.6.6.4 Vehicles transporting blasting agents shall be in safe operating condition at all times.
- 3.4.6.7 Use of Blasting Agents. Persons using blasting agents shall comply with all of the applicable provisions of a paragraph 3.4.5.
- 3.4.7 Water Gel (Slurry) Explosives and Blasting Agents
 - 3.4.7.1 General Provisions. Unless otherwise set forth in this paragraph, water gels shall be transported, stored and used in the same manner as explosives or blasting agents in accordance with the classification of the product.
 - 3.4.7.2 Types and Classifications
 - 3.4.7.2.1 Water gels containing a substance in itself classified as an explosive shall be classified as an explosive and manufactured, transported, stored, and used as specified for “explosives” in this section. except as noted in this subparagraph.

- 3.4.7.2.2 Water gels containing no substance in itself classified as an explosive and which are capsensitive as defined in paragraph 3.4.1 under Blasting Agent shall be classified as an explosive and manufactured, transported, stored and used as specified for “explosives” in this section.
- 3.4.7.2.3 Water gels containing no substance in itself classified as an explosive and which are not cap-sensitive as defined in paragraph 4.4.1 under Blasting Agent shall be classified as blasting agents and manufactured, transported, stored, and used as specified for “blasting agents” in this section.
- 3.4.7.2.4 When tests on specific formulations of water gels result in classification as a Class B explosive, bullet-resistant magazines are not required, see subparagraph 3.4.3.2.
- 3.4.7.3 Fixed Location Mixing
 - 3.4.7.3.1 Buildings used for the mixing of water gels shall conform to the requirements of this subparagraph.
 - 3.4.7.3.1.1 Buildings shall be of noncombustible construction or sheet metal on wood studs and have lightning protection.
 - 3.4.7.3.1.2 Floors in a mixing plant shall be of concrete or of other nonabsorbent materials.
 - 3.4.7.3.1.3 Where fuel oil is used all fuel oil storage facilities shall be separated from the mixing plant and located in such a manner that in case of tank rupture, the oil will drain away from the mixing plant budding.
 - 3.4.7.3.1.4 The building shall be ventilated.
 - 3.4.7.3.1.5 Heating units that do not depend on combustion processors, when properly designed and located, may be used in the building. All direct sources of heat shall be provided exclusively from units located outside of the mixing building.
 - 3.4.7.3.1.6 All internal-combustion engines used for electric power generation shall be located outside the mixing plant building, or shall be properly ventilated and isolated by a firewall. The exhaust system on all such engines shall be fitted with approved, efficient spark arresters and shall also be located so any spark emission cannot be a hazard to any materials in or adjacent to the plant.
 - 3.4.7.3.2 Ingredients of water gels shall conform to the requirements of this subparagraph,
 - 3.4.7.3.2.1 Ingredients in themselves classified as Class A or Class B explosives shall be stored in conformity with paragraph 3.4.3.
 - 3.4.7.3.2.2 Nitrate-water solutions may be stored in tank cars, tank trucks, or fixed tanks without quantity or distance limitations. Spills or leaks which may contaminate combustible materials shall be cleaned up immediately.
 - 3.4.7.3.2.3 Metal powders such as aluminum shall be kept dry and shall be stored in containers or bins which are moisture-resistant or weathertight. Solid fuels shall be used in such manner as to minimize dust explosion hazards.

- 3.4.7.3.2.4 Ingredients shall not be stored with incompatible materials. Peroxides and chlorates shall not be used.
- 3.4.7.3.3 Mixing equipment shall comply with the requirements of this subparagraph.
- 3.4.7.3.3.1 The design of the processing equipment, including mixing and conveying equipment, shall be compatible with the relative sensitivity of the materials being handled. Equipment shall be designed to minimize the possibility of frictional heating, compaction, overloading, and confinement.
- 3.4.7.3.3.2 Both equipment and handling procedures shall be designed to prevent the introduction of foreign objects or materials.
- 3.4.7.3.3.3 Mixers, pumps, valves, and related equipment shall be designed to permit regular and periodic flushing, cleaning, dismantling, and inspection.
- 3.4.7.3.3.4 All electrical equipment including wiring, switches, controls, motors, and lights, shall conform to the requirements of Section 7.0.
- 3.4.7.3.3.5 All electric motors and generators shall be provided with suitable overload protection devices. Electrical generators, motors, proportioning devices, and all other electrical enclosures shall be electrically bonded. The grounding conductor to all such electrical equipment shall be effectively bonded to the service-entrance ground connection and to all equipment ground connections in a manner so as to provide a continuous path to ground.
- 3.4.7.3.4 Mixing facilities shall comply with the fire prevention requirements of this subparagraph.
- 3.4.7.3.4.1 The mixing, loading, and ingredients transfer areas where residues or spilled materials may accumulate shall be cleaned periodically.
- 3.4.7.3.4.2 A cleaning and collection system for dangerous residues shall be provided.
- 3.4.7.3.4.3 A daily visual inspection shall be made of mixing, conveying, and electrical equipment to establish that such equipment is in good operating condition. A program of systematic maintenance shall be conducted on regular schedule.
- 3.4.7.3.4.4 Heaters which are not dependent on the combustion process within the heating unit may be used within the confines of processing buildings, or compartments, if provided with temperature and safety controls and located away from combustible materials and the finished product.
- 3.4.7.4 Bulk Delivery and Mixing Vehicles
- 3.4.7.4.1 The design of vehicles shall comply with the requirements of this subparagraph.
- 3.4.7.4.1.1 Vehicles used over public highways for the bulk transportation of water gels or of ingredients classified as dangerous commodities, shall meet the requirements of paragraph 4.4.4 and subparagraph 3.4.6.6.
- 3.4.7.4.1.2 When electric power is supplied by self-contained motor generator located on the vehicle the generator shall be at a point separate from where the water gel is discharged.

Table 3.4-2

**Table of recommended separation distances of ammonium nitrate and
blasting agents from explosives or blasting agents ⁽¹⁾**

Donor weight kilograms (Not over)	Minimum separation distance of acceptor when barricaded(2) (m)		Minimum thickness of artificial barricades ⁽³⁾
	Ammonium Nitrate	Blastings Agent	
45	0.9	3.4	30
140	1.2	4.3	30
270	1.5	5.5	30
450	1.8	6.7	30
730	2.1	7.6	30
900	2.4	8.8	30
1400	2.7	9.8	38
1800	3.0	11.0	38
2700	3.4	12.2	38
3600	3.7	13.1	51
4500	4.0	14.3	51
5400	4.3	15.2	51
7300	4.6	16.5	64
9100	4.9	17.7	64
11300	5.5	19.8	64
13600	5.8	20.7	76
15900	6.1	21.9	76
18100	6.4	23.2	76
20500	6.7	24.1	89
23000	7.0	25.3	89
25000	7.3	26.2	89
27000	7.6	27.4	89
32000	7.9	28.7	100
36000	8.8	30.8	100
40000	9.1	32.9	100
45000	9.6	35.1	100
55000	10.4	37.2	127
64000	11.3	40.5	127
73000	12.9	43.9	127
82000	13.4	48.2	127
90000	14.6	52.7	127
100000	15.8	57.0	150
113000	17.1	61.6	150
125000	18.3	65.8	150
136000	19.5	70.1	150

Note 1: *These distances apply to the separation of stores only.*

Note 2: *When the ammonium nitrate and/or blasting agent is not barricaded, the distances shown in the table shall be multiplied by six. These distances allow for the possibility of high velocity metal fragments from mixers, hoppers, truck bodies, sheet metal structures, metal containers, and the like which may enclose the "donor". Where storage is in bullet-resistant wall recommended for explosives or where the storage is protected by a bullet-resistant magazines recommended for explosives or where the storage is protected by a bullet-resistant wall, distances, and barricade thicknesses in excess of those prescribed are not required.*

Note 3: *Earth, or sand dikes, or enclosures filled with the prescribed minimum thickness of earth or sand are acceptable artificial barricades. Natural barricades, such as hills or timber of sufficient density that the surrounding exposures which require protection cannot be seen from the "donor" when the trees are bare of leaves, are also acceptable.*

Note 4: *When the ammonium nitrate must be counted in determining the distances to be maintained, it may be counted at one-half its actual weight because its blast effect is lower.*

Note 5: *Guide to use of table of recommended separation distances of ammonium nitrate and blasting agents from explosives or blasting agents:*

Sketch location of all potential donor and acceptor materials together with the maximum mass of material to be allowed in that vicinity. Consider separately each donor mass in combination with each acceptor mass. If the masses are closer than table allowance (distances measured between nearest edges), the combination of masses becomes a new potential donor of weight equal to the total mass. When individual masses are considered as donors, distances to potential acceptors shall be measured between edges. When combined masses within propagating distance of each other are considered as a donor, the appropriate distance to the edge of potential acceptors shall be computed as a weighted distance from the combined masses.

Calculation of weighted distance from combined masses:

Let $M_2, M_3 \dots M_n$ be donor masses to be combined.

M_1 is a potential acceptor mass.

D_{12} is distance from M_1 to M_2 (edge to edge).

D_{13} is distance from M_1 to M_3 (edge to edge), etc.

To find weighted distance D_1 (2,3. ... n) from combined masses to M_1 add the products of the individual masses and distances and divide the total by their sum of the masses thus:

$$D_1 (2,3... n) = \frac{M_2 \times D_{12} + M_3 \times D_{13} + M_n \times D_{1n}}{M_2 + M_3... + M_n}$$

Propagation is possible if either an individual donor mass is less than the tabulated distance from an acceptor or a combined mass is less than the weighted distance from an acceptor.

In determining the distances from potential explosions, the sum of all masses which may propagate (i.e., lie at distances less than prescribed in the Table) from either individual or combined donor masses are included. However, when the ammonium nitrate must be included, only 50 percent of its weight shall be used because of its reduced blast effects. Distances are measured from the nearest edge of potentially explodable material. When all or part of a potential acceptor comprises Explosives Class A, storage in bullet-resistant magazines is required. Safe distances to stores in bullet-resistant magazines may be obtained from the intermagazine distance prescribed in subparagraph 4.4.3.1.6. Barricades must not have line-of-sight openings between potential donors and acceptors which permit blast or missiles to move directly between masses.

Good housekeeping practices shall be maintained around any bin containing ammonium nitrate or blasting agent. This includes keeping weeds and other combustible materials cleared within 7.5 m of such bin. Accumulation of spilled product on the ground shall be prevented.

- 3.4.7.4.1.3 The design of processing equipment and general requirements shall conform to subparagraph 3.4.7.3.
- 3.4.7.4.2 A positive action parking brake which will set the wheel brakes on at least one axle shall be provided on vehicles when equipped with air brakes and shall be used during bulk delivery operations. Wheel chocks shall supplement parking brakes whenever conditions may require.
- 3.4.7.4.3 The placarding requirements contained in subparagraph 3.4.4.2.2, applies to vehicles carrying water gel explosives or blasting agents.
- 3.4.7.4.4 The operator shall be trained in the safe operation of the vehicle together with its mixing, conveying, and related equipment. He shall be familiar with the commodities being delivered and the general procedure for handling emergency situations.
- 3.4.7.4.5 The hauling of either blasting caps or other explosives, but not both, shall be permitted on bulk trucks provided that a special wood or nonferrous-lined container in which they will be carried is installed.
- 3.4.7.4.6 No person shall be allowed to smoke, carry matches or any flame-producing device, or carry any firearms while in or about bulk vehicles effecting the mixing, transfer, or down-the-hole loading of water gels at or near the blasting site.
- 3.4.7.4.7 Caution shall be exercised in the movement of the vehicle in the blasting area to avoid driving the vehicle over or dragging hoses or firing lines, cap wires, or

explosive materials. The employer shall furnish the driver the assistance of a second person to guide the driver's movements.

3.4.7.4.8 No intransit mixing of materials shall be performed.

3.4.7.4.9 The location chosen for water gel or ingredient transfer from a supports vehicle into the borehole loading vehicle shall be away from the blasthole site when the boreholes are loaded or in the process of being loaded.

3.4.8 Storage of Ammonium Nitrate

3.4.8.1 Scope. Except as provided in subparagraph 3.4.6.2, this paragraph supplies to the storage of ammonium nitrate in the form of crystals, flakes, grains, or prills including fertilizer grade, dynamite grade, nitrous oxide grade, technical grade, and other mixtures containing 60 percent or more ammonium nitrate by weight but does not apply to blasting agents. This paragraph does not apply to the transportation of ammonium nitrate.

Nothing in this paragraph shall apply to the production of ammonium nitrate or to the storage of ammonium nitrate on the premises of the producing plant, provided that no distinct undue hazard to the public is created.

3.4.8.2 General Provisions

3.4.8.2.1 This paragraph applies to all persons storing, having, or keeping ammonium nitrate, and to the owner or lessee of any building, premises, or structure in which ammonium nitrate is stored in quantities of 450 kg or more.

3.4.8.2.2 Approval of large quantity storage shall be subject to due consideration of the fire and explosion hazards, including exposure to toxic vapors from burning or decomposing ammonium nitrate.

3.4.8.2.3 Storage buildings shall not have basements unless the basements are open on at least one side. Storage buildings shall not be over one story in height.

3.4.8.2.3.1 Storage buildings shall have ventilation or be of a construction that will be self-ventilating in the event of fire.

3.4.8.2.3.2 The wall on the exposed side of a storage building within 15 m of a combustible building, piles of combustible materials and similar exposure hazards shall be of fire-resistive construction. In lieu of the fire-resistive wall, other suitable means of exposure protection such as a free standing wall may be used.

3.4.8.2.3.3 All flooring in storage and handling areas, shall be of non-combustible material or protected against impregnation by ammonium nitrate and shall be without open drains, traps, tunnels, pits, or pockets into which any molten ammonium nitrate could flow and be confined in the event of fire.

3.4.8.2.3.4 Buildings and structures shall be dry and free from water seepage through the roof, walls, and floors.

3.4.8.3 Storage of Ammonium Nitrate in Bags, Drums, or other Containers

- 3.4.8.3.1 Container of ammonium nitrate shall not be accepted for storage when the temperature of the ammonium nitrate exceeds 54°C.
- 3.4.8.3.2 The height of piles shall not exceed 6 m. The width of piles shall not exceed 6 m and the length 15 m except that where the building is of non-combustible construction or is protected by automatic sprinklers the length of piles shall not be limited. In no case shall the ammonium nitrate be stacked closer than 1 m below the roof or supporting and spreader beams overhead or sprinkler heads.
- 3.4.8.3.3 Aisles shall be provided to separate piles by a clear space of not less than 1 m in width. At least one service or main aisle in the storage area shall be not less than 1.2 m in width.
- 3.4.8.4 Storage of Bulk Ammonium Nitrate
 - 3.4.8.4.1 Warehouses shall have ventilation or be capable of ventilation in case of fire.
 - 3.4.8.4.2 Unless constructed of non-combustible material or unless adequate facilities for fighting a roof fire are available, bulk storage structures shall not exceed a height of 12 m.
 - 3.4.8.4.3 Bins shall be clean and free of materials which may contaminate ammonium nitrate.
 - 3.4.8.4.3.1 Due to the corrosive and reactive properties of ammonium nitrate, and to avoid contamination, galvanized iron, copper, lead, and zinc shall not be used in a bin construction unless suitably protected.
 - 3.4.8.4.3.2 Aluminum bins and wooden bins protected against impregnation by ammonium nitrate are permissible.
 - 3.4.8.4.3.3 The partitions dividing the ammonium nitrate storage from other products which would contaminate the ammonium nitrate shall be of tight construction.
 - 3.4.8.4.3.4 The ammonium nitrate storage bins or piles shall be clearly identified by signs reading "Ammonium Nitrate" with letters at least 5 cm high.
 - 3.4.8.4.4 Piles or bins shall be so sized and arranged that all materials in the pile is moved out periodically in order to minimize possible caking of the stored ammonium nitrate.
 - 3.4.8.4.5 Height or depth of piles shall be limited by the pressure-setting tendency of the product. However, in no case shall the ammonium nitrate be piled higher at any point than 1 m below the roof of supporting and spreader beams overhead.
 - 3.4.8.4.6 Ammonium nitrate shall not be accepted for storage when the temperature of the product exceeds 54°C.
 - 3.4.8.4.7 Dynamite, other explosives, and blasting agents shall not be used to break up or loosen caked ammonium nitrate.
- 3.4.8.5 Contaminants

- 3.4.8.5.1 Ammonium nitrate shall be in a separate building or shall be separated by approved type firewalls of not less than 1 hour fire-resistance rating from storage of organic chemicals, acids, or other corrosive materials, materials that may require blasting during processing or handling, compressed flammable gases, flammable and combustible materials or other contaminating substances, including but not limited to animal fats, baled cotton, baled rags, baled scrap paper, bleaching powder, burlap or cotton bags, caustic soda, coal, coke, charcoal, cork, camphor, excelsior, fibers of any kind, fish oils, fish meal, foam rubber, hay, lubricating oil, linseed oil, or other oxidizable or drying oils, naphthalene, oakum, oiled clothing, oiled paper, oiled textiles, paint, straw, sawdust, wood shavings, or vegetable oils.
- 3.4.8.5.1.1 In lieu of separation walls, ammonium nitrate may be separated from the materials referred to in the above subparagraph by a space of at least 10 m.
- 3.4.8.5.1.2 Flammable liquids such as gasoline, kerosene, solvents, and light fuel oils shall not be stored on the premises except when such storage conforms to related Gulf standard.
- 3.4.8.5.1.3 LP-Gas shall not be stored on the premises.
- 3.4.8.5.1.4 Sulfur and finely divided metals shall not be stored in the same building with ammonium nitrate except when such storage conforms to paragraphs 3.4.3 through 3.4.8.
- 3.4.8.5.1.5 Explosives and blasting agents shall not be stored in the same building with ammonium nitrate except on the premises of makers, distributors, and user-compounders of explosives or blasting agents.
- 3.4.8.5.1.6 Where explosives or blasting agents are stored in separate buildings, other than on the premises of makers, distributors, and user-compounders of explosives or blasting agents, they shall be separated from the ammonium nitrate by the distances and/or barricades specified in Table 3.4-2, but by not less than 15 m.
- 3.4.8.5.1.7 Storage and/or operations on the premises of makers, distributors, and user-compounders of explosives or blasting agents shall be in conformity with paragraphs 3.4.3 through 3.4.8.
- 3.4.8.6 General Precautions
- 3.4.8.6.1 Electrical installations shall conform to the requirements of Section 7.0, for ordinary locations. They shall be designed to minimize damage from corrosion.
- 3.4.8.6.2 Lightning protection shall be provided.
- 3.4.8.6.3 Provisions shall be made to prevent unauthorized personnel from entering the ammonium nitrate storage area.
- 3.4.8.7 Fire Protection

- 3.4.8.7.1 Not more than 2250 metric tons of bagged ammonium nitrate shall be stored in a building or structure not equipped with an automatic sprinkler system. Sprinkler systems shall be installed in accordance with related Gulf standard.
- 3.4.8.7.2 Suitable fire control devices such as small hose or portable extinguishers shall be provided throughout the warehouse and in the loading and unloading areas. Devices shall comply with related Gulf standard.
- 3.4.8.7.3 Water supplies and fire hydrants shall be available in accordance with recognized good engineering practices.
- 3.4.9 Underground Transportation of Explosives
 - 3.4.9.1 All explosives or blasting agents in transit underground shall be taken to the place of use or storage without delay. The quantity of explosives or blasting agents taken to an underground loading area shall not exceed the amount estimated to be necessary for the blast.
 - 3.4.9.2 Explosives in transit shall not be left unattended.
 - 3.4.9.3 The hoist operator shall be notified before explosives or blasting agents are transported in a shaft conveyance.
 - 3.4.9.4 Trucks used for the transportation of explosives underground shall have the electrical system checked weekly to detect any failures which may constitute an electrical hazard. A written record of such inspections shall be kept on file.
 - 3.4.9.5 The installation of auxiliary lights on truck beds, which are powered by the truck's electrical system, shall be prohibited.
 - 3.4.9.6 Explosives and blasting agents shall be hoisted, lowered, or conveyed in a power car. No other materials, supplies, or equipment shall be transported in the same conveyance at the same time.
 - 3.4.9.7 No one, except the operator, his helper, and the powderman, shall be permitted to ride on a conveyance transporting explosives and blasting agents.
 - 3.4.9.8 No person shall ride in any shaft conveyance transporting explosives and blasting agents.
 - 3.4.9.9 No explosives or blasting agents shall be transported on any locomotive. At least two car lengths shall separate the locomotive from the powder car.
 - 3.4.9.10 No explosives or blasting agents shall be transported on a man haul trip.
 - 3.4.9.11 The car or conveyance containing explosives or blasting agents shall be pulled, not pushed, whenever possible.
 - 3.4.9.12 The powder car or conveyance especially built for the purpose of transporting explosives or blasting agents shall bear a reflectorized sign on each side with the word "Explosives" in letters, not less than 10 cm in height; upon a background of sharply contrasting color.

- 3.4.9.13 Compartments for transporting detonators and explosives in the same car or conveyance shall be physically separated by a distance of 70 cm or by a solid partition at least 15 cm thick.
- 3.4.9.14 Detonators and other explosives shall not be transported at the same time in any shaft conveyance.
- 3.4.9.15 Explosives, blasting agents, or blasting supplies shall not be transported with other materials.
- 3.4.9.16 Explosives or blasting agents, not in original containers, shall be placed in a suitable container when transported manually.
- 3.4.17 Detonators, primers, and other explosives shall be carried in separate containers when transported manually.
- 3.4.10 Underground storage of explosives and blasting agents.
 - 3.4.10.1 No explosives or blasting agents shall be permanently stored in any underground operation until the operation has been developed to the point where at least two modes of exit have been provided.
 - 3.4.10.2 Permanent underground storage magazines shall be at least 90 m from any shaft, adit, or active underground working area.
 - 3.4.10.3 Permanent underground magazines containing detonators shall not be located closer than 15 m to any magazine containing other explosives or blasting agents.
- 3.4.11 Underground Loading of Explosives or Blasting Agents
 - 3.4.11.1 Procedures that permit safe and efficient loading shall be established before loading is started. See subparagraph 3.4.5.4.
 - 3.4.11.2 Powerlines and portable electric cables for equipment being used shall be kept a safe distance from explosives or blasting agents being loaded into drill holes. Cables in the proximity of the blast area shall be deenergized and locked out by the blaster in conjunction with a qualified electrician.
 - 3.4.11.3 Holes shall be checked prior to loading to determine depth and conditions. Where a hole has been loaded with explosives but the explosives have failed to detonate, there shall be no drilling within 15 m of the hole.
 - 3.4.11.4 When loading a long line of holes with more than one loading crew, the crews shall be separated by practical distance consistent with efficient operation and supervision of crews.
 - 3.4.11.5 No explosive shall be loaded or used underground in the presence of combustible gases or combustible dusts.
 - 3.4.11.6 All blast holes in open work shall be stemmed to the collar or to a point which will confine the charge.

- 3.4.11.7 Warning signs, indicating a blast area, shall be maintained at all approaches to the blast area. The warning sign lettering shall not be less than 10 cm in height on a contrasting background.
- 3.4.11.8 A bore hole shall never be sprung when it is adjacent to or near a hole that is loaded. Flashlight batteries shall not be used for springing holes.
- 3.4.11.9 Drill holes which have been sprung or chambered, and which are not water-filled, shall be allowed to cool before explosives are loaded.
- 3-4.12 Initiation of Explosive Charges - Electric Blasting
- 3.4.12.1 Electric blasting caps shall not be used where sources of extraneous electricity make the use of electric blasting caps dangerous. Blasting cap leg wires shall be kept short-circuited (shunted) until they are connected into the circuit for firing.
- 3.4.12.2 Before adopting any system of electrical firing, the blaster shall conduct a thorough survey for extraneous currents, and all dangerous currents shall be eliminated before any holes are loaded.
- 3.4.12.3 In any single blast using electric blasting caps, all caps shall be of the same style or function, and of the same manufacture.
- 3.4.12.4 Electric blasting shall be carried out by using blasting circuits or power circuits in accordance with the electric blasting cap manufacturer's recommendations, or an approved contractor or his designated representative.
- 3.4.12.5 When firing a circuit of electric blasting caps, care must be exercised to ensure that an adequate quantity of delivered current is available, in accordance with the manufacturer's recommendations.
- 3.4.12.6 Connecting wires and lead wires shall be insulated single solid wires of sufficient current-carrying capacity.
- 3.4.12.7 Bus wires shall be solid single wires of sufficient current-carrying capacity.
- 3.4.12.8 When firing electrically, the insulation on all firing lines shall be adequate and in good condition.
- 3.4.12.9 A power circuit used for firing electric blasting caps shall not be grounded.
- 3.4.12.10 In underground operations when firing from a power circuit, a safety switch shall be placed in the permanent firing line at intervals. This switch shall be made so it can be locked only in the "Off" position and shall be provided with a short-circuiting arrangement of the firing lines to the cap circuit.
- 3.4.12.11 In underground operations there shall be a "lighting" gap of at least 1.5 m in the firing system ahead of the main firing switch; that is, between this switch and source of power. This gap shall be bridged by a flexible jumper cord just before firing the blast.
- 3.4.12.12 When firing from a power circuit, the firing switch shall be locked in the "Open" or "Off" position at all times, except when firing. It shall be so designed that the

firing lines to the cap circuit are automatically short-circuited when the switch is in the "Off" position. Keys to this switch shall be entrusted only to the blaster.

- 3.4.12.13 Blasting machines shall be in good condition and the efficiency of the machine shall be tested periodically to make certain that it can deliver power at its rated capacity.
- 3.4.12.14 When firing with blasting machines, the connections shall be made as recommended by the manufacturer of the electric blasting caps used.
- 3.4.12.15 The number of electric blasting caps connected to a blasting machine shall not be in excess of its rated capacity. Furthermore, in primary blasting, a series circuit shall contain no more caps than the limits recommended by the manufacturer of the electric blasting caps in use.
- 3.4.12.16 The blaster shall be in charge of the blasting machines, and no other person shall connect the leading wires to the machine.
- 3.4.12.17 Blasters, when testing circuits to charged holes, shall use only blasting galvanometers equipped with a silver chloride cell especially designed for this purpose.
- 3.4.12.18 Whenever the possibility exists that a leading line or blasting wire might be thrown over a live powerline by the force of an explosion, care shall be taken to see that the total length of wires are kept too short to hit the lines, or that the wires are securely anchored to the ground. If neither of these requirements can be satisfied, a nonelectric system shall be used.
- 3.4.12.19 In electrical firing, only the blaster making leading wire connections shall fire the shot. All connection shall be made from the bore hole back to the source of firing current, and the leading wires shall remain shorted and not be connected to the blasting machine or other source of current until the charge is to be fired.
- 3.4.12.20 After firing an electric blast from a blasting machine, the leading wires shall be immediately disconnected from the machine and short-circuited.
- 3.4.13 Use of Safety Fuse
 - 3.4.13.1 Safety fuse shall only be used where sources of extraneous electricity make the use of electric blasting caps dangerous. The use of a fuse that has been hammered or injured in any way shall be forbidden.
 - 3.4.13.2 The hanging of a fuse on nails or other projections which will cause a sharp bend to be formed in the fuse is prohibited.
 - 3.4.13.3 Before capping safety fuse, a short length shall be cut from the end of the supply reel so as to assure a fresh cut end in each blasting cap.
 - 3.4.13.4 Only a cap crimper of approved design shall be used for attaching blasting caps to safety fuse. Crimpers shall be kept in good repair and accessible for use.

- 3.4.13.5 No unused cap or short capped fuse shall be placed in any hole to be blasted; such unused detonators shall be removed from the working place and destroyed.
- 3.4.13.6 No fuse shall be capped, or primers made up, in any magazine or near any possible source of ignition.
- 3.4.13.7 No one shall be permitted to carry detonators or primers of any kind on his person.
- 3.4.13.8 The minimum length of safety fuse to be used in blasting shall not be less than 80 cm.
- 3.4.13.9 At least two men shall be present when multiple cap and fuse blasting is done by hand lighting methods.
- 3.4.13.10 Not more than 12 fuses shall be lighted by each blaster when hand lighting devices are used. However, when two or more safety fuses in a group are lighted as one by means of igniter cord, or other similar fuse-lighting devices, they may be considered as one fuse.
- 3.4.13.11 The so called “drop fuse” method of dropping or pushing a primer or any explosive with a lighted fuse attached is forbidden.
- 3.4.13.12 Cap and fuse shall not be used for firing mudcap charges unless charges are separated sufficiently to prevent one charge from dislodging other shots in the blast.
- 3.4.13.13 When blasting with safety fuses, consideration shall be given to the length and burning rate of the fuse. Sufficient time, with a margin of safety, shall always be provided for the blaster to reach a place of safety.
- 3.4.14 Use of Detonating Cord
 - 3.4.14.1 Care shall be taken to select a detonating cord consistent with the type and physical condition of the bore hole and stemming and the type of explosives used.
 - 3.4.14.2 Detonating cord shall be handled and used with the same respect and care given other explosives.
 - 3.4.14.3 The line of detonating cord extending out of a bore hole or from a charge shall be cut from the supply spool before loading the remainder of the bore hole or placing additional charges.
 - 3.4.14.4 Detonating cord shall be handled and used with care to avoid damaging or severing the cord during and after loading and hooking-up.
 - 3.4.14.5 Detonating cord connections shall be in accordance with cord manufacturers recommended methods. Knot-type or other cord-to-cord connections shall be made only with detonating cord in which the explosive core is dry.
 - 3.4.14.6 All detonating cord trunklines and branchlines shall be free of loops, sharp kinks, or angles that direct the cord back toward the oncoming line of detonation.
 - 3.4.14.7 All detonating cord connections shall be inspected before firing the blast.

- 3.4.14.8 When detonating cord millisecond-delay connectors or short-interval-delay electric blasting caps are used with detonating cord, the practice shall conform strictly to the manufacturer's recommendations.
- 3.4.14.9 When connecting a blasting cap or an electric blasting cap to detonating cord, the cap shall be taped or otherwise attached securely along the side and the end of the cap containing the explosive charge pointed in the direction in which the detonation is to proceed.
- 3.4.14.10 Detonators for firing the trunkline shall not be brought to the loading area nor attached to the detonating cord until everything else is in readiness for the blast.
- 3.4.15 Firing The Blast
 - 3.4.15.1 A code of blasting signals equivalent to Table 4.4-3, shall be posted on one or more conspicuous places at the operation, and all employees shall be required to familiarize themselves with the code and conform to it. Danger signs shall be placed at suitable locations.
 - 3.4.15.2 Before a blast is fired, a loud warning signal shall be given by the blaster in charge, who has made certain that all surplus explosives are in a safe place and all employees, vehicles, and equipment are at a safe distance, or under sufficient cover.
 - 3.4.15.3 Flagmen shall be safely stationed on highways which pass through the danger zone so as to stop traffic during blasting operations.
 - 3.4.15.4 It shall be the duty of the blaster to fix the time of blasting.
 - 3.4.15.5 Before firing an underground blast, warning shall be given, and all possible entries into the blasting area, and any entrances to any working place where a drift, raise, or other opening is about to hole through, shall be carefully guarded. The blaster shall make sure that all employees are out of the blast area before firing a blast.

Table 3-3

Warning Signal. A 1-min series of long horn or siren signals 5 min prior to blast signal.

Blast Signal. A series of short horn or siren signals 1 min prior to the shot.

All Clear Signal. A prolonged horn or siren signal following the inspection of blast area.

- 3.4.16 Inspection After Blasting
 - 3.4.16.1 Immediately after the blast has been fired, the firing line shall be disconnected from the blasting machine, or where power switches are used, they shall be locked open or in the off position.
 - 3.4.16.2 Sufficient time shall be allowed, not less than 15 min. in tunnels, for the smoke and fumes to leave the blasted area before returning to the shot. An inspection of the area and the surrounding rubble shall be made by the blaster to determine if all

charges have been exploded before employees are allowed to return to the operation, and in tunnels, after the muck pile has been wetted down.

3.4.17 Misfires

3.4.17.1 If a misfire is found, the blaster shall provide proper safeguards for excluding all employees from the danger zone.

3.4.17.2 No other work shall be done except that necessary to remove the hazard of the misfire and only those employees necessary to do the work shall remain in the danger zone.

3.4.17.3 No attempt shall be made to extract explosives from any charged or misfired hole; a new primer shall be put in and the hole reblasted. If refiring of the misfired hole presents a hazard, the explosives may be removed by washing out with water or, where the misfire is under water, blown out with air.

3.4.17.4 If there are any misfires while using cap and fuse, all employees shall remain away from the charge for at least 1 hour. Misfires shall be handled under the direction of the person in charge of the blasting. All wires shall be carefully traced and a search made for unexploded charges.

3.4.17.5 No drilling, digging, or picking shall be permitted until all missed holes have been detonated or the authorized representative has approved that work can proceed.

3.4.18 Underwater Blasting

3.4.18.1 A blaster shall conduct all blasting operations, and no shot shall be fired without his approval.

3.4.18.2 Leading tubes and casings of dissimilar metals shall not be used because of possible electric transient currents from galvanic action of the metals and water.

3.4.18.3 Only, water-resistant blasting caps and detonating cords shall be used for all marine blasting. Loading shall be done through a non-sparking metal loading tube when tube is necessary.

3.4.18.4 No blast shall be fired while any vessel under way is closer than 450 m to the blasting area. Those on board vessels or craft moored or anchored within 450 m shall be notified before a blast is fired.

3.4.18.5 No blast shall be fired while any swimming or diving operations are in progress in the vicinity of the blasting area. If such operations are in progress, signals and arrangements shall be agreed upon to assure that no blast shall be fired while any person is in the water.

3.4.18.6 Blasting flags shall be displayed.

3.4.18.7 In addition to the requirements of this paragraph, the storage, handling and use of explosives aboard vessels shall also be according to other applicable provisions outlined in Section 3.4.

- 3.4.18.8 When more than one charge is placed under water, a float device shall be attached to an element of each charge in such manner that it will be released by the firing. Misfires shall be handled in accordance with the requirements of paragraph 3.4.17.
- 3.4.19 Blasting in Excavation Work Under Compressed Air
- 3.4.19.1 Detonators and explosives shall not be stored or kept in tunnels, shafts, or caissons. Detonators and explosives for each round shall be taken directly from the magazines to the blasting zone and immediately loaded. Detonators and explosives left over after a round shall be removed from the working chamber before the connecting wires are connected up and returned to magazines.
- 3.4.19.2 When detonators or explosives are brought into an air lock, no employee except the powderman, blaster, lock tender and the employees necessary for carrying, shall be permitted to enter the air lock. No other material, supplies, or equipment shall be locked through with the explosives.
- 3.4.19.3 Detonators and explosives shall be taken separately into pressure working chambers.
- 3.4.19.4 The blaster or powderman shall be responsible for the receipt, unloading, storage, and onsite transportation of explosives and detonators.
- 3.4.19.5 All metal pipes, rails, air locks, and steel tunnel lining shall be electrically bonded together and grounded at or near the portal or shaft, and such pipes and rails shall be cross-bonded together at not less than 300 m intervals throughout the length of the tunnel. In addition, each low air supply pipe shall be grounded at its delivery end.
- 3.4.19.6 The explosives suitable for use in wet holes shall be water-resistant and shall be Fume Class 1 or develop less than 4531. cu cm of poisonous gases per approximately 200 gm of detonated explosive.
- 3.4.19.7 When tunnel excavation in rock face is approaching mixed face, and when tunnel excavation is in mixed face, blasting shall be performed with light charges and with light burden on each hole. Advance drilling shall be performed as tunnel excavation in rock face approaches mixed face, to determine the general nature and extent of rock cover and the remaining distance ahead to soft ground as excavation advances.